Technical Report 249

FIFTH ANNUAL SURVEY REPORT ON THE AIR WEATHER SERVICE WEA MODIFICATION PROGRAM (FY 1972)

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PREFACE

This report is the fifth in a series of annual surveys of the AWS weather-modification program. It describes briefly those projects undertaken during FY 1972, including the techniques, equipment, and results. This report is intended to inform the AWS community of the current status of our rapidly changing capabilities in weather modification. It has not been written to provide the technical details of concern to the weather-modification specialist. Detailed reports on individual projects are published as results warrant and given limited distribution.

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FIFTH ANNUAL SURVEY REPORT ON THE AIR WEATHER SERVICE WEATHER MODIFICATION PROGRAM [FY 1972]

SECTION A — INTRODUCTION

In early 1967, the AF assigned AWS the mission of weather modification in support of military operations. To carry out this assignment, AWS (a) monitors all weather-modification research and development to determine those areas which are within the scientific state-of-the-art, (b) carries out field tests to make state-of-the-art techniques operational, and (c) applies the resultant techniques in support of actual operations. So far, only the dissipation of fog (cold, warm, and ice) has been considered sufficiently advanced to justify AWS field testing. Even so, the warm-fog (except for the costly heat systems and the limited helicopter downdraft procedure) and ice-fog techniques have proved generally disappointing in field tests, indicating the need for further research and development. Consequently, in FY 72 AWS again invested most of its field testing and operational support in the dissipation of supercooled fog. AWS will continue to monitor the research and development efforts by the scientific community in warm-fog dissipation, precipitation augmentation, hail and lightning suppression, and hurricane modification and, where mutually desirable, will assist such programs within its capabilities.

In FY 72 AWS carried out a total of six field projects — five to dissipate supercooled fog and one to dissipate ice fog. COLD WAND and COLD FLAKE were ground-based techniques at Fairchild AFB and Hahn AB, respectively, and COLD CLEAR was an airborne technique in Alaska and Europe. In addition, FY 72 saw the installation of a ground system at Elmendorf AFB, Alaska, designed to replace airborne seeding there. Project COOL VIEW was an AWS field test of ice-fog dissipation techniques at Eielson AFB, Alaska. A brief description of procedures, equipment, and results of the tests listed below is given in the following sections.

TABLE 1. Field Projects FY 72.

Project	Location	Mode	Agent
COLD WAND	Fairchild AFB	Ground-based	Liquid Propane
COLD FLAKE	Hahn AB	Ground-based	Liquid Propane
COLD CLEAR	Europe	Airborne	Dry Ice
COLD CLEAR	Alaska	Airborne	Dry Ice
GROUND-BASED ELMENDORF	Elmendorf AFB	Ground-based	Liquid Propane
COOL VIEW	Eielson AFB	Airborne	Helicopter Downwash

SECTION B — GROUND-BASED PROPANE SYSTEMS

COLD FLAKE

Cold-fog dispersal activities were conducted under Operation COLD FLAKE at Hahn AB, Germany, between 12 November 1971 and 29 February 1972. Liquid propane released from ground dispensers initiated the dispersal process. The theory of supercooled fog dissipation is explained in detail in AWS TR 177 (Rev). Briefly, the liquid propane vaporizes and cools a small volume in the vicinity of the dispensing nozzle. Numerous ice crystals are created by the cooling and are diffused throughout the fog by wind and turbulence. These crystals grow at the expense of the fog droplets and eventually fall to the ground as snow, thus, increasing visibility.

Actual installation of the ground system at Hahn was completed in December 1970; however, the occurrence of nozzle icing precluded useful testing. Therefore, 1971-72 was the first real test of the system. Basically, the system consists of 24 fixed propane dispensers positioned in two arcs 5 and 10 miles from the base (Figure 1). The dispensers were located in the SE quadrant on the basis of climatology, which indicated that 60% of the fog at Hahn occurs with wind directions of E-SSE. Of these winds, 55% are of speeds greater than 7 knots; consequently, the two separate arcs were constructed.

The primary dispensers, one of which is seen in Figure 2, consist of an 800-kg (440-gal) propane tank connected through 1/2-inch pipes to orifices at the top of 20-ft towers. The liquid propane is forced through the siphon tube in the bottom of the tank and up the 1/2-inch pipe to the top of the tower by means of the vapor pressure (about 3 atmospheres at 0°C) in the propane tank. Propane is turned on and off by hand and is dispensed at the rate of 15 gal/hr. In addition to the fixed dispensers, a mobile dispensing capability was acquired in FY 72 for use in evaluating the suitability of additional dispensing locations. These dispensers, shown in Figure 3, are capable of dispensing propane for about 30 minutes at 10 gal/hr.

During actual operating conditions, the duty forecaster alerted the project technical adviser when cold fog, with visibility less than 1 nautical mile, occurred or was forecast to occur within the next two hours. If conditions seemed favorable, the technical adviser determined seeding wind, dispenser usage, test objective, and number of teams needed. Teams usually responded within 30 minutes and were subsequently briefed on weather, safety, and individual responsibilities. Radio communications with deployed personnel allowed adjustments in operating mode following receipt of initial field observations. After turn-on was accomplished, dispenser operators patrolled the area downwind of the dispensers for evidence of ice-crystal fallout and clearing. Dispensers were operated until the test objective was achieved, conditions for seeding became unsuitable, or until the ground system seemed to have failed; in which

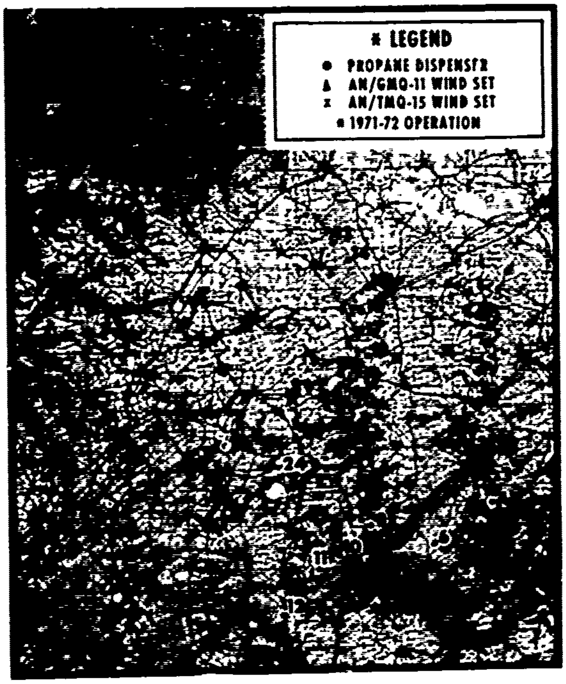

Figure 1. Hahn Dispenser and Equipment Locations.

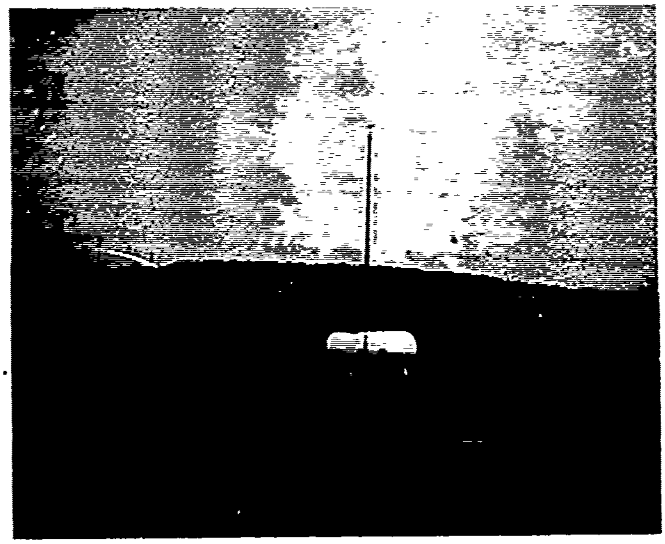

Figure 2. Propane Dispenser at Hahn AB.

case, the airborne system attempted to clear the fog.

Thirteen operational test seedings and 5 plume tests were conducted during the 1971-72 season. Of the 13 test seedings, 3 produced operational clearings, 3 were partially successful, 4 were complete failures, and 3 were inconclusive due to natural variability. Table 2 is a summary of all 13 seedings with reasons for failure where applicable.

Figure 3. Mobile Propane Dispenser at Hahn AB.

The primary reason for the poor success rate was the presence of marginal temperature conditions. Because of terrain, patchy fog, type of fog, etc., maximum temperature at which clearing can be reliably achieved is about 28.0°F. Of 287 cold-fog hours affecting Hahn AB in 1971-72, only 9.7% or 27 hours were with temperatures of less than 28.4°F. Most of these "sufficiently cold" periods were unsuitable due to erratic winds, natural variability, or

short fog duration. Climatology indicates that, on the annual average, 3 to 4 times as much fog at temperatures < 28.4°F can be expected as was reported in 1971-72.

Besides temperature, other possibly significant problems arose in the area of targeting, fog distribution, and liquid-water content of fog. The key targeting difficulties encountered were (a) an erratic "split flow" upwind of Hahn which, at times, caused effects of seeding to pass north and south of the base, (b) much lighter winds in the area nearby than at Hahn itself, especially near the outer row, and (c) more southerly winds in the vicinity of the dispensers than at Hahn. Nonhomogeneous fog in the field and the occasional high liquid-water content of fog also were responsible at times for poor test results. However, all of the above-mentioned problem areas must be monitored during "good" temperature conditions before their impact on clearing quality can be accurately gauged.

TABLE 2. COLD FLAKE FY 72 Results Summary.

Op Test #	Date	Results	Remarks
1	2 Dec 71	F	T
2	18 Dec 71	S	-
3	27 Dec 71	F	T
4	2 Jan 72	F	Marginal T; W; NF
5	6 Jan 72	P/S	Marginal T; NF; W
6	7 Jan 72	P/S	NF; W
7	14 Jan 72	P/S	LWC; Marginal T; W
8	15 Jan 72	F	LWC; Marginal T
9	26 Jan 72	S	NC
10	26 Jan 72	S	NC
11	2 Feb 72	I	
12	4 Feb 72	I	
13	19 Feb 72	I	Post-analysis showed seedable conditions never occurred-restriction mostly haze.

Results Legend

F = Failure (No improvement due to seeding)
I = Inconclusive (Seedable conditions did not persist long enough to determine results.)
S = Success (Achieved desired minimums)
P/S = Partial Success (Improved conditions, but did not achieve desired mins)

Remarks Legend

T = Temperature too warm
W = Wind and Targeting problem
NF = No fog at dispenser sites
NC = Natural clearing may have been a factor
LWC = High Liquid Water Content

One area of concern solved during FY 72 was the occurrence of nozzle icing. Nozzle icing plagued the project in 1970-71 and again in the initial stages of 1971-72. Extensive testing of propane flow under diverse temperatures, nozzle sizes, and nozzle configurations confirmed that icing was strictly a function of water in the propane. The problem was solved by having the propane vendor add 1.1% isopropyl alcohol to the propane prior to delivery.

Support to the 50 TFWg was poor mainly due to adverse weather conditions. Most of Europe experienced an unusually warm and dry winter; consequently, only 2 F-4 launches can be credited to ground-based seeding. During a normal fog year, seeding results and operational support (launches and recoveries) should be considerably more extensive.

ELMENDORF GROUND SYSTEM

Since the winter of 1967-68, cold fog has been routinely dispersed at Elmendorf AFB by means of airborne seeding with crushed dry ice. While these seeding operations have been very successful, expense has been high and reaction time slow. Consequently, during the spring of 1971, the 11 WSq, in conjunction with Hq AWS and 4 WWg, investigated the feasibility of installing a ground-based propane system at Elmendorf AFB. Upon consideration of terrain and fog climatology, it became apparent that such a system would have a high probability of success, and on 25 May 1971 the Commander, Alaskan Air Command approved the construction of a remote-controlled ground-based propane system at Elmendorf AFB. The resulting 19-dispenser network was located as shown in Figure 4 because the majority of winds occurring in conjunction with supercooled fog are from the north through southeast at speeds of 0 to 4 knots. No coverage is provided for rarely occurring wind directions. Targeting of the runway may be difficult (due to terrain between the dispensers and the runway); with the present configuration, however, the extent of the problem (if any) won't be known until after extensive testing in actual fog conditions.

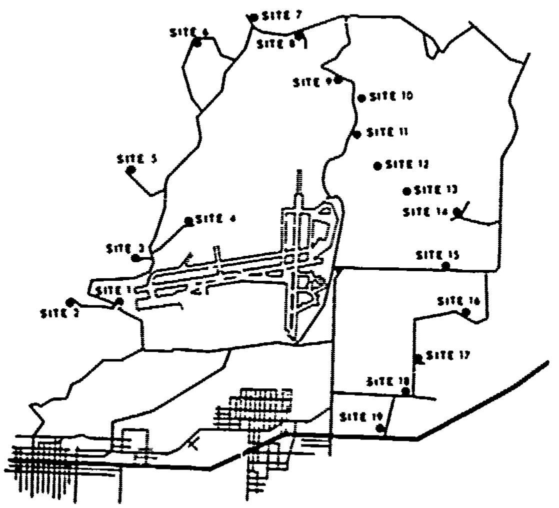

Figure 4. Location of Propane Dispensers at Elmendorf AFB.

Figure 5. Elmendorf Propane Dispenser.

The equipment at each site, shown in Figure 5, consists of a 1000-gallon propane tank, a 20-foot vertical pipe with two nozzles at the top through which the propane is dispensed, a radio switch which controls a solenoid propane-release valve for remote operation, and an automotive battery to provide power to radio and solenoid. To preclude the requirement for additional manning and to decrease response time, the radio-controlled Motorola 504 System was integrated into the system. The system's control console is located in the base weather station and is linked to a continuous-duty base radio and repeater station. Each of the propane sites is equipped with a receiver decoder powered by a 12-volt automotive battery. Upon receiving the appropriate code, the receiver closes a relay which applies 12 volts to the solenoid, opening it and releasing propane.

During actual operations the chief duty forecaster is responsible for monitoring the potential for fog development and supervising the dispersal operations in the event of fog occurrence. Whenever the forecaster determines that fog will occur within 2½ hours, he monitors wind data available from a sensor located 100 feet above the runway, and dispatches a roving observer to take wind and fog observations in the field. Based on these two sources of data, he then determines which array of sites must be activated. Operating as backup, the airborne system will be launched to provide aerial reconnaissance and real-time intelligence of the ground system's effectiveness; and, in the event the propane system fails, to provide airborne seeding support. The use of a roving observer and the airborne system as a backup will be terminated when the ground system is declared operational.

The ground network was installed and ready for manual operation in early January 1972. Some mechanical problems were experienced with the radios and solenoids; however, the entire system was declared operational for remote control by 17 January 1972. Unfortunately, absolutely no cold fog affected Elmendorf in January, February, and March; therefore, the system could not be tested to determine reliability. However, extensive flow tests were conducted and mechanically the system functioned very smoothly. Cost of the system is documented in Table 3. The $60,760 installation cost and the $7,400 annual recurring costs compare quite favorably with the $362,500 spent on the airborne system at Elmendorf in FY 72.

TABLE 3. Ground-based Cost Breakdown.

a. Total one-time costs associated with procurement of the Elmendorf propane system:

Item	Cost
Construction	$ 44,441.00
Purchase of radio remote control system including voice communications	11,387.00
Radio equipment installation	1,513.00
Fencing for five sites	3,419.00
TOTAL	60,760.00
Annual one-time costs prorated to a 10-yr life expectancy are:	6,076.00

b. Estimated annual recurring costs associated with maintaining the syste and procurement of expendable supplies:

Item	Cost
Propane	$ 6,000.00
Nontactical radio maintenance	1,200.00
General maintenance and supply (no consumption rate has been established as yet, value represents a minimum)	200.00
Total Annual recurring cost:	7,400.00

COLD WAND

The first AWS propane dispenser network was established at Fairchild AFB, Washington in 1968-69. Since that time the network has undergone frequent modification as to numbers and locations of dispensers. In 1971-72 the network consisted of 23 dispensers as shown in Figure 6. Thirteen (1-13) of the dispensers were equipped to permit remote turn-on and turn-off from the Base Weather Station via telephone lines.

Operation of the propane system at Fairchild during 1971-72 was essentially routine in nature with little technical documentation during discrete seeding events. Consequently, only a brief rundown of operational results will be presented here. An extensive discussion of equipment and technique can be found in AWSTR 236. The continuing plans for complete

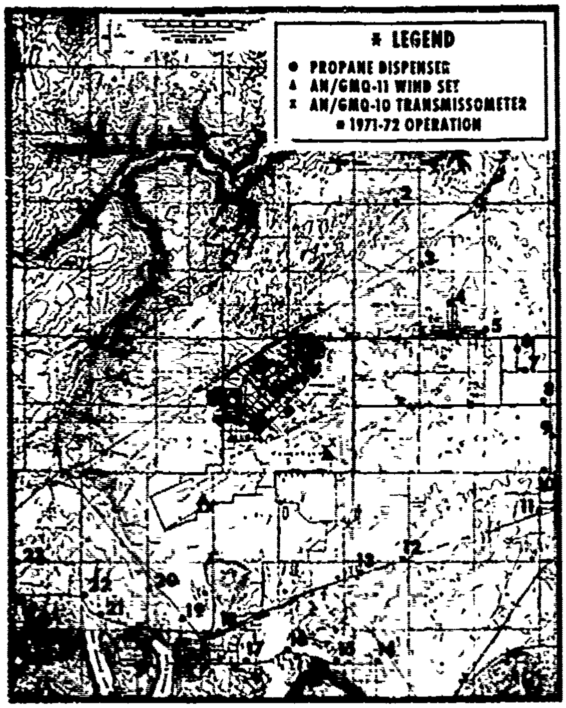

Figure 6. Location of Propane Dispensers at Fairchild AFB.

automation of the network will be discussed later.

FY 72 was slightly above average as a cold-fog year at Fairchild AFB with cold fog affecting the airbase for 164 hours. The mean is 146 hours. The dispenser network performed admirably with a total of 62 launches and 37 recoveries credited to seeding operations. There were 9 diversions during the season mostly due to the inaccessibility of key dispensers because of deep snow.

During operation of the partially automated system in FY 72, it became apparent that the telephone-line technique was both costly and troublesome. In addition, the Air Force had recognized the practicality of radio control as the means of automating ground-based fog-dispersal equipment and a prototype radio system was under development. Therefore, after the 1971-72 season all telephone-line hookups were deleted and construction of a radio-controlled system similar to that installed at Elmendorf AFB was scheduled to begin in the fall of 1972. The only difference between the Fairchild and Elmendorf systems will be the addition of a verification light on the control console at Fairchild to insure that propane is being dispensed. The network will be run in the manual mode during FY 73 pending complete installation of the Motorola 504 System.

SECTION C — COLD CLEAR

Project COLD CLEAR (previously COLD COWL and COLD CRYSTAL) is a continuing operational program designed to provide airborne cold-fog dispersal to AF bases in Alaska and Europe. After the 1970-71 operating season the airborne dispersal technique was termed completely operational and technical support from Hq AWS was no longer deemed necessary. As a consequence, the FY 72 projects will be described very briefly with emphasis on support statistics. Both projects used WC-130s as seeding platforms and both used similar crusher/dispensers for dry-ice seeding. For additional details on technique and equipment used during the two airborne projects see AWSTR 213.

Airborne cold-fog abatement operations were conducted at Elmendorf AFB, Alaska, under Project COLD CLEAR from 15 November 1971 through 10 February 1972. Seeding was conducted whenever air traffic was scheduled if (a) the base was below minimums or (b) existing fog in the area might move onto the base. The only difficulty encountered during the project was with the latter phenomenon and then only under certain conditions. When the Susitna Valley, north of Elmendorf, became filled with fog, initial clearing with a standard seeding pattern was successful; however, keeping the field open thereafter with preventive seeding (seeding along the upwind edge of the standard pattern) proved unsuccessful.

During FY 73 this problem will again be investigated to determine if preventive seeding techniques can be refined to maintain VFR conditions indefinitely.

Total flying time in support of COLD CLEAR-Alaska operations during FY 72 was:

Mission	Flying Time
Seeding Operations	81.5
Training Flights	42.5
Deployment/Redeployment of WC-130 Aircraft	310.8
Support to Alaskan Ice Fog Suppression Test	20.0
Total Hours	454.8

Table 4 gives a breakdown of costs incurred during the Alaskan cold-fog operations. In summary, seeding resulted or aided in the recovery of 127 aircraft and expedited the departure of 121 aircraft.

TABLE 4. Cost of Airborne Cold-Fog Operations at Elmendorf AFB, Alaska.

Alaskan Air Command		
Manpower	See Note	
Supplies	12,009.00	
Equipment	1,430.00	
	Subtotal	$ 13,439.00
4WWg		
Manpower	2,260.90	
Expendable Supplies	200.00	
Dry Ice	8,462.09	
	Subtotal	10,922.99
11WSq		
Manpower	16,666.33	
Expendable Supplies	200.00	
	Subtotal	16,866.33
9WRWg		
Manpower	9,000.00	
Expendable Supplies	200.00	
	Subtotal	9,200.00
54WRSq - Task Flight Echo		
Manpower	130,874.81	
TDY Costs	14,431.00	
Flying Hour Cost (Base Rate 367.00/hr)	166,851.60	
	Subtotal	312,157.41
	TOTAL	$ 362,585.73

NOTE: Alaskan Air Command did not compute manpower cost figures for FY 72.

Table 5 itemizes by organization aircraft arrivals and departures aided during the indicated months. As seen from the Table, the winter of 1971-72 was somewhat anomalous as no cold fog and, consequently, no related launches or recoveries occurred during January and February. However, in general, FY 72 resulted in another successful year of support to AAC and MAC operations.

TABLE 5. Summary of Aircraft Arrivals/Departures.

	MAC	AAC	ARMY	NAVY	COAST GUARD	ANG	AERO CLUB	CIVILIAN AIRLINE	UNK	TOTAL
Arrivals										
NOV	21	42	0	2	0	2	14	4	1	86
DEC	18	9	5	0	0	0	8	1	0	41
JAN	0	0	0	0	0	0	0	0	0	0
FEB	0	0	0	0	0	0	0	0	0	0
TOTAL	39	51	5	2	0	2	22	5	1	127
Departures										
NOV	13	46	2	0	0	2	14	3	1	81
DEC	15	16	0	0	1	0	8	0	0	40
JAN	0	0	0	0	0	0	0	0	0	0
FEB	0	0	0	0	0	0	0	0	0	0
TOTAL	28	62	2	0	1	2	22	3		121

In contrast, COLD CLEAR operations, which were conducted in Europe from 15 November 1971 to 15 February 1972, were generally disappointing. The concept of COLD CLEAR in Europe was to support as many as three out of eight AF bases assuming cold fog was hindering operations across the board. While three WC-130s were committed to the project, aircraft availability was such that normally only two were actually airworthy. In addition to poor aircraft availability, overall weather conditions in Europe were not conducive to good seeding success. As stated earlier in Section B, Europe had an above-average year with respect to temperature and a below-average year (except for Hahn) with respect to precipitation and fog.

Support in Europe was geared for times of most traffic, i.e., 0600 to 1500L, Monday through Saturday. Table 6 shows the number of cold-fog hours experienced in the above time frame during the operating period. As can be seen, cold-fog occurrence was very low and actually not one clear-cut case of seedable cold fog occurred. Those seedings attempted were all conducted during marginal conditions. Support statistics compiled during COLD CLEAR-Europe by the various bases are shown in Table 7. The limitation on technique imposed by weather conditions was the primary reason for the poor results.

SECTION D — COOL VIEW

Project COOL VIEW was an Alaskan Air Command-sponsored and AWS-advised project from 1 December 1971 through 15 February 1972 to investigate the possibility of using mechanical mixing to dissipate ice fog at Eielson AFB, Alaska.

TABLE 6. Fog (Temp $\leq$ 31°F, Cig/Vsby $<$ 300 ft/1 nm) Occurrence by Base Between 0600 - 1500L

Cold Fog	Air Base
18.2 hours	Ramstein
28.8 hours	Wiesbaden
110.1 hours	Hahn
34.3 hours	Rhein Main
16.3 hours	Mildenhall
29.8 hours	Bitburg
30.0 hours	Spangdahlem
27.0 hours	Zweibrucken

TABLE 7. Aircraft Launches/Recoveries Credited To Seeding.

Air Base	Launches	Recoveries
Ramstein	2	0
Wiesbaden	4	9
Hahn	14	5
Rhein Main	4	1
Mildenhall	0	0
Bitburg	0	0
Spangdahlem	0	0
Zweibrucken	0	0
TOTAL	24	15

Helicopter downwash and wing-tip vortex mixing were considered to be the best ways to accomplish the necessary mixing and were supported by previous test efforts in the Eielson area. During the 1970-71 ice-fog season, December and January, independent tests were conducted by Hicks and Kumai (1971) of the Army's Cold Regions Research and Engineering Laboratory (CRREL) and by personnel from 11th Weather Squadron. Tests conducted by Hicks on 9 January 1971 resulted in cleared flight paths which persisted less than one minute, while a test on 14 January failed to produce the expected clearing. He concluded "clearings in ice fog large enough to allow VFR helicopter operations can be made under certain meteorological conditions." Similarly, exploratory downwash tests were conducted by 11th Weather Squadron personnel who reported visibility increases in the downwash zone to above 1/2 mile. Additionally, personnel at Eielson reported that visibility often increased after a low pass by a heavy fixed-wing aircraft. Based upon these reports, AAC and AWS concluded that further testing and documentation were justified.

That helicopter downwash could result in visibility improvements in the affected zone was attributed to the apparent existence of dry air above the very strong surface inversion which usually accompanies ice-fog occurrences. In general, radiation fogs have been found to be capped by a layer of warmer air which is at a lower relative humidity than the air nearer the surface and below the radiation inversion. Using this phenomenon to advantage, Hicks (1965) produced downwash clearings at Thule, Greenland, in warm fog and Plank, et al (1970) reported similar success in a project conducted at Lewisburg, West Virginia. Assuming this atmospheric structure to also be common in the Arctic, it seemed most reasonable that, if this warmer, and supposedly drier, air from above the surface inversion could be pumped down into the ice fog, some degree of visibility improvement would result.

To exploit this possibility, AAC committed an HH-3 and a C-130A to Project COOL VIEW while US Army, Alaska (USARAL) committed a CH-47 and AWS committed both a WC-130 and a WC-135. The WC-135, however, was never used due to a lack of test opportunities, and the AAC C-130A was never used due to nonavailability

during ice-fog occurrences. The HH-3 operated out of Eielson, the CH-47 from Ft. Wainwright nearby, and the WC-130 staged out of Elmendorf AFB where it was positioned to seed supercooled fog under Project COLD CLEAR. Technical direction was provided by the AWS On-Site Test Director (OSTD) at Eielson. Daily coordination was conducted via telecon with the 11 WSq Weather Modification Director (WMPD) at Elmendorf AFB. On test days the OSTD flew with the HH-3 while the WMPD flew with the WC-130 from Elmendorf (see Figures 7 and 8).

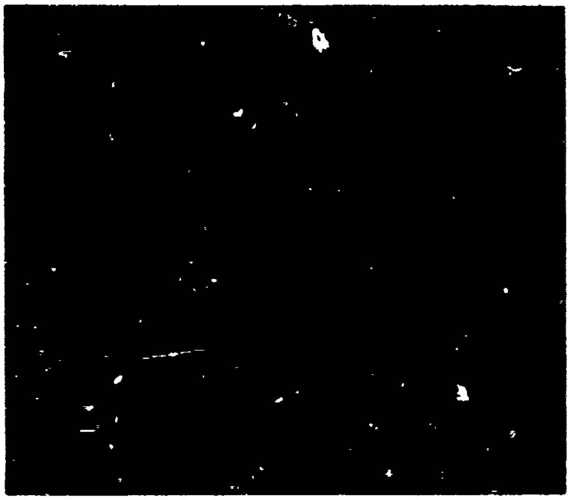

Figure 7. Eielson AFB and Ice Fog from 19,000 Feet. At the time of this picture the prevailing visibility was 1/2 mile with 1/4 mile being reported locally in the flight line area.

Figure 8. Eielson AFB and Ice Fog from Low Altitude. Ice fog is a man-caused phenomenon and is generally confined to the immediate area of his activities. Ice fog is generally only 50 to 100 feet deep. The tower is approximately 125 feet high.

In all, operations were conducted on only four days during the test period; the 9th, 14th, 16th, and 19th of January. On each day the field visibility at Eielson dropped to 1/4 mile or below due to ice fog.

CASE 1. On 9 January the surface temperature was -45°F with scattered cirrus clouds, calm winds, and the visibility ranging between 1/8 and 3/4 of a mile. Nine tests were attempted by the WC-130 and HH-3 aircraft using different altitudes, speeds, and aircraft configurations for each test. In no case was any effect of the WC-130 or HH-3 observable either from the air or on the ground. Analysis of the Fairbanks radiosonde data indicated a frost-point depression of between 2°C and 4°C at 500 feet above the top of the surface inversion.

CASE 2. On 14 January 1972 the surface temperature was -35°F with scattered stratus at 700 feet (probably power-plant plume), calm winds, and visibility less than 1/2 mile. Helicopters were not available this day and the WC-130 made three test passes. Following one test the WMPD observed shallow depressions

formed by the WC-130 wing-tip vortices, but no change in the surface visibility could be detected.

CASE 3. On 16 January surface conditions were reported as temperature -45°F, calm winds, and the visibility hovering near 3/8 mile. Six tests were conducted by the WC-130 and the CH 47. No effects were observed during the two WC-130 passes, but all four of the CH-47 passes resulted in either an increase in the observed density of the ice fog over the field or in the formation of ice fog in clear areas away from the field (twice). The ice fog generated by the tw tests over clear areas gradually lowered, flattened out along the ground, and persisted as long as observed (see Figures 9 and 10).

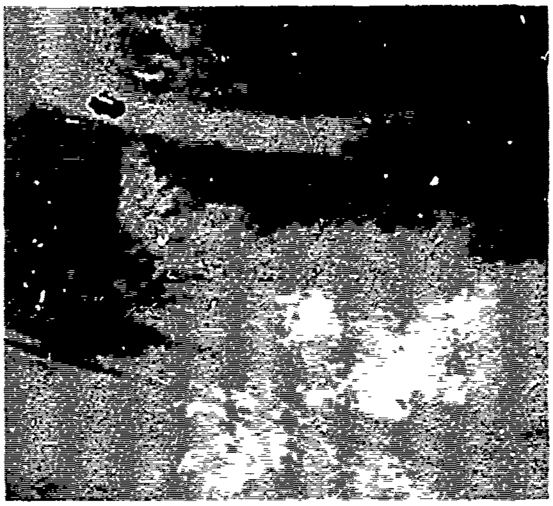

Figure 9. Helicopter Wake Effects, 16 January 1972. The CH-47 is leaving a distinct trail of ice fog. The brighter area is presumed to be liquid water droplets which have have not yet evaporated or frozen. The less bright fog created is composed of ice crystals.

Figure 10. Fog Created by Helicopter Over Clear Area, 16 January 1972. Over a clear area away from Eielson the CH-47 created two patches of ice fog close to the surface which persisted as long as observed.

The frost-point depression above the ice-fog layer averaged one to two degrees Centigrade.

CASE 4. On 19 January tests were conducted by the CH-47 and HH-3 in areas away from Eielson itself. In a series of hovers and slow flight maneuvers, no signs of ice-fog generation were observed. When operations were conducted over areas of the ice fog, no changes due to the downwash could be observed. The frost-point depression was again 2 to 4 degrees at 500 feet above the top of the surface inversion.

As a result of the variety of results observed during the test program, an extensive analysis was accomplished to try to arrive at meaningful correlations,

if indeed, any existed. It was found that the only consistent correlation was between the frost point in clear air above the fog and the observed downwash effects. With a frost-point depression of less than 2°C at 500 feet above the top of the surface inversion, downwash effects consistently resulted in ice-fog generation. At frost-point depressions from 2°C to 4°C at the same levels, no effects from downwash were observed, i.e., fog was neither thickened or dissipated.

Based upon these findings it was decided to review Hicks' tests of the year before. It was found that on 9 January 1971, when clearings were produced, the frost-point depression at 500 feet above the surface inversion was 4.5°C. On 14 January 1971, when no clearing was produced, the frost-point depression was 3.1°C. Although the sample is small, it would appear that the comparison of these two tests would suggest that successful clearings by a downwash technique can be expected only when the frost-point depression at the helicopter flight level is greater than 4°C. In an attempt to determine how frequently this condition could be expected to occur, an analysis of 10 years of Fairbanks radiosonde data was requested from USAFETAC. Completed in June 1972, this study revealed that the proper conditions for helicopter downwash can be expected to occur less than 30% of the time. Based upon the low frequency of opportunity and the uncertainties involved in downwash operations themselves, it was decided that further testing of this technique would not be conducted.

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13. ABSTRACT

This annual report of the weather-modification activities of the Air Weather Service covers the projects, their operation and results, undertaken during FY 1972. Its primary purpose is to inform AWS field personnel of the progress in weather modification made during the year. Details of the projects are only briefly discussed as such details are published elsewhere, if warranted. COLD FLAKE, COLD WAND, COLD CLEAR, COOL VIEW, and the Elmendorf ground-based propane system are the activities covered by this report.

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